What is claimed is:

1. A polarization separation device comprising:

a diffractive optical element layer formed out of an optically substantially isotropic transparent sheet and having a diffraction grating surface; and

an optically anisotropic layer formed out of an optically anisotropic birefringent material and disposed contiguously with the diffraction grating surface,

wherein the diffractive optical element layer is 0.1 to 1 mm thick.

2. A polarization separation device as claimed in claim 1,

wherein the diffractive optical element layer is made of a thermoplastic resin.

3. A polarization separation device as claimed in claim 1,

wherein the diffraction grating surface has a blazed grating, and fulfills conditional formulae (1), (2), and (3) or (4) below:

$$1.5 < H < 6 \quad (1)$$

$$0.1 < \Delta n < 0.3 \quad (2)$$

$$np \approx no \quad (3)$$

$$np \approx ne \quad (4)$$

where

H represents a diffraction grating height (μm);

Δn represents whichever refractive index difference $|np - no|$ or $|np - ne|$ is

greater;

np represents a refractive index of the diffractive optical element layer;

no represents a refractive index for ordinary light of the optically anisotropic layer; and

ne represents a refractive index for extraordinary light of the optically anisotropic layer.

4. A polarization separation device as claimed in claim 1, further comprising:

a transparent substrate disposed contiguously with the optically anisotropic layer in such a way that the optically anisotropic layer is sandwiched between the transparent substrate and the diffractive optical element layer,

wherein the optically anisotropic layer is made of nematic or smectic liquid crystal, and

wherein, on a surface of the transparent substrate that faces the optically anisotropic layer, an orientation film is provided that has been subjected to a rubbing process so that molecules of the liquid crystal are oriented homogeneously along grooves of the diffraction grating surface.

5. A polarization separation device as claimed in claim 4,

wherein the transparent substrate and the diffractive optical element layer have substantially equal linear expansion coefficients.

6. A polarization separation device comprising:

a first transparent flat plate;

a second transparent flat plate;

a diffractive optical element disposed between the first and second transparent flat plates and formed as a thin sheet or film of an optically substantially isotropic transparent resin; and

liquid crystal sealed in between the first and second transparent flat plates,

wherein the diffractive optical element has a flat surface on a side thereof facing the first transparent flat plate and has a blazed diffraction grating surface on a side thereof facing the second transparent flat plate,

wherein, with the first and second transparent flat plates firmly fitted together with sealant, the liquid crystal is sealed in between the first and second transparent flat plates so as to be contiguous with the diffraction grating surface, and

wherein a surface of the second transparent flat plate that faces the diffractive optical element has been subjected to an orientation process.

7. A polarization separation device as claimed in claim 6,

wherein the diffractive optical element is, at the flat surface thereof, bonded to the first transparent flat plate.

8. A polarization separation device as claimed in claim 6,

wherein the diffractive optical element and the first and second transparent flat plates are firmly fitted together with the sealant.

9. A polarization separation device as claimed in claim 6,

wherein the diffractive optical element is made of a thermoplastic resin.

10. A polarization separation device as claimed in claim 6,

wherein, on a surface of the first or second transparent flat plate that faces away from the diffractive optical element, a first lens array having a plurality of lens cells with which to separate incident light is formed as part of an integrator.

11. A polarization separation device comprising:

a first transparent flat plate;

a second transparent flat plate;

a diffractive optical element disposed between the first and second transparent flat plates and formed as a thin sheet or film of an optically substantially isotropic transparent resin; and

liquid crystal sealed in between the first and second transparent flat plates,

wherein the diffractive optical element has blazed diffraction grating surfaces on both sides thereof facing the first and second transparent flat plates,

wherein, with the first and second transparent flat plates firmly fitted together with sealant, the liquid crystal is sealed in between the first and second transparent flat plates so as to be contiguous with the diffraction grating surface, and

wherein surfaces of the first and second transparent flat plates that face the diffractive optical element have been subjected to an orientation process.

12. A polarization separation device as claimed in claim 11,

wherein the diffractive optical element and the first and second transparent flat plates are firmly fitted together with the sealant.

13. A polarization separation device as claimed in claim 11,

wherein the diffractive optical element is made of a thermoplastic resin.

14. A polarization separation device as claimed in claim 11,

wherein, on a surface of the first or second transparent flat plate that faces away from the diffractive optical element, a first lens array having a plurality of lens cells with which to separate incident light is formed as part of an integrator.

15. An illumination optical system comprising:

a light source for emitting illumination light;

an integrator rod for making spatial energy distribution of the illumination light emitted from the light source uniform;

a polarization separation device as claimed in claim 6 for separating the illumination light that has exited from the integrator rod into two linearly polarized light components having mutually perpendicular polarization planes;

a relay lens for relaying the two linearly polarized light components separated by the polarization separation device; and

polarization plane rotating means for rotating the polarization plane of one of the two linearly polarized light components through about 90° in vicinity of an aperture stop position of the relay lens, or in vicinity of a position conjugate therewith, so as to make polarization of light that exits from the relay lens uniform.

16. An illumination optical system as claimed in claim 15,

wherein the diffraction grating surface fulfills conditional formulae (1), (2), and (3) or (4) below:

$$1.5 < H < 6 \quad (1)$$

$$0.1 < \Delta n < 0.3 \quad (2)$$

$$np \approx no \quad (3)$$

$$np \approx ne \quad (4)$$

where

H represents a diffraction grating height (μm);

Δn represents whichever refractive index difference $|np - no|$ or $|np - ne|$ is greater;

np represents a refractive index of the diffractive optical element;

no represents a refractive index for ordinary light of the liquid crystal; and

ne represents a refractive index for extraordinary light of the liquid crystal.

17. An illumination optical system as claimed in claim 15,

wherein the diffraction grating surface fulfills conditional formula (5) below:

$$5 < D < 15 \quad (5)$$

where

D represents a diffraction grating pitch (μm).

18. An illumination optical system as claimed in claim 15, further comprising:

a UV/IR cut filter disposed between the light source and the polarization separation device.

19. An illumination optical system as claimed in claim 15,

wherein the polarization plane rotating means is a half-wave plate.

20. An illumination optical system comprising:

a light source for emitting illumination light;

an integrator rod for making spatial energy distribution of the illumination light emitted from the light source uniform;

a polarization separation device as claimed in claim 11 for separating the illumination light that has exited from the integrator rod into two linearly polarized light components having mutually perpendicular polarization planes;

a relay lens for relaying the two linearly polarized light components separated by the polarization separation device; and

polarization plane rotating means for rotating the polarization plane of one of the two linearly polarized light components through about 90° in vicinity of an aperture stop position of the relay lens, or in vicinity of a position conjugate therewith, so as to make polarization of light that exits from the relay lens uniform.

21. An illumination optical system as claimed in claim 20,

wherein the diffraction grating surface fulfills conditional formulae (1), (2), and (3) or (4) below:

$$1.5 < H < 6 \quad (1)$$

$$0.1 < \Delta n < 0.3 \quad (2)$$

$$np \approx no \quad (3)$$

$$np \approx ne \quad (4)$$

where

H represents a diffraction grating height (μm);

Δn represents whichever refractive index difference |np − no| or |np − ne| is greater;

np represents a refractive index of the diffractive optical element;

no represents a refractive index for ordinary light of the liquid crystal; and

ne represents a refractive index for extraordinary light of the liquid crystal.

22. An illumination optical system as claimed in claim 20, wherein the diffraction grating surface fulfills conditional formula (5) below:

$$5 < D < 15 \quad (5)$$

where

D represents a diffraction grating pitch (μm).

23. An illumination optical system as claimed in claim 20, further comprising: a UV/IR cut filter disposed between the light source and the polarization separation

device.

24. An illumination optical system as claimed in claim 20, wherein the polarization plane rotating means is a half-wave plate.

25. An illumination optical system comprising:

a light source for emitting illumination light;

a first lens array and a second lens array for making spatial energy distribution of the illumination light emitted from the light source uniform;

a polarization separation device as claimed in claim 6 for separating the illumination light into two linearly polarized light components having mutually perpendicular polarization planes in vicinity of the first lens array; and

polarization plane rotating means for rotating the polarization plane of one of the two linearly polarized light components through about 90° in vicinity of the second lens array, or in vicinity of a position conjugate therewith, so as to make polarization of light that exits from the second lens array uniform.

26. An illumination optical system as claimed in claim 25, wherein the diffraction grating surface fulfills conditional formulae (1), (2), and (3) or (4) below:

$$1.5 < H < 6 \tag{1}$$

$$0.1 < \Delta n < 0.3 \tag{2}$$

$$np \approx no \tag{3}$$

$$np \approx ne \tag{4}$$

where

H represents a diffraction grating height (μm);

Δn represents whichever refractive index difference |np – no| or |np – ne| is greater;

np represents a refractive index of the diffractive optical element;

no represents a refractive index for ordinary light of the liquid crystal; and

ne represents a refractive index for extraordinary light of the liquid crystal.

27. An illumination optical system as claimed in claim 25, wherein the diffraction grating surface fulfills conditional formula (5) below:

$$5 < D < 15 \tag{5}$$

where

D represents a diffraction grating pitch (μm).

28. An illumination optical system as claimed in claim 25, further comprising: a UV/IR cut filter disposed between the light source and the polarization separation device.

29. An illumination optical system as claimed in claim 25, wherein the polarization plane rotating means is a half-wave plate.

30. An illumination optical system comprising:

a light source for emitting illumination light;

a first lens array and a second lens array for making spatial energy distribution of the illumination light emitted from the light source uniform;

a polarization separation device as claimed in claim 11 for separating the illumination light into two linearly polarized light components having mutually perpendicular polarization planes in vicinity of the first lens array; and

polarization plane rotating means for rotating the polarization plane of one of the two linearly polarized light components through about 90° in vicinity of the second lens array, or in vicinity of a position conjugate therewith, so as to make polarization of light that exits from the second lens array uniform.

31. An illumination optical system as claimed in claim 30,

wherein the diffraction grating surface fulfills conditional formulae (1), (2), and (3) or (4) below:

$$1.5 < H < 6 \quad (1)$$

$$0.1 < \Delta n < 0.3 \quad (2)$$

$$np \approx no \quad (3)$$

$$np \approx ne \quad (4)$$

where

H represents a diffraction grating height (μm);

Δn represents whichever refractive index difference $|np - no|$ or $|np - ne|$ is greater;

np represents a refractive index of the diffractive optical element;

no represents a refractive index for ordinary light of the liquid crystal; and

ne represents a refractive index for extraordinary light of the liquid crystal.

32. An illumination optical system as claimed in claim 30, wherein the diffraction grating surface fulfills conditional formula (5) below:

$$5 < D < 15 \qquad (5)$$

where

D represents a diffraction grating pitch (μm).

33. An illumination optical system as claimed in claim 30, further comprising: a UV/IR cut filter disposed between the light source and the polarization separation device.

34. An illumination optical system as claimed in claim 30, wherein the polarization plane rotating means is a half-wave plate.

35. A blazed grating device comprising: a plate-shaped transparent substrate having a blazed grating formed on a surface thereof; and

a separation coating formed on the blazed grating of the transparent substrate so as to reflect or transmit incident light according to properties of the incident light.

36. A blazed grating device as claimed in claim 35, further comprising:

a plate-shaped transparent member kept in intimate contact with the blazed grating of the transparent substrate with the separation coating sandwiched in between.

37. A blazed grating device as claimed in claim 36, further comprising:

a blazed grating formed on a surface of the transparent member that faces away from the transparent substrate;

a separation coating formed on the blazed grating of the transparent member so as to reflect or transmit incident light according to properties of the incident light; and

a plate-shaped transparent member kept in intimate contact with the blazed grating of the transparent member with the separation coating sandwiched in between.

38. A blazed grating device as claimed in claim 35,

wherein the separation coating reflects or transmits the incident light according to how the incident light is polarized.

39. A blazed grating device as claimed in claim 35,

wherein the separation coating reflects or transmits the incident light according to a wavelength of the incident light.

40. A blazed grating device as claimed in claim 35,

wherein the separation coating reflects or transmits the incident light according to an angle of incidence of the incident light.

41. A diffraction grating device comprising:

a plate-shaped transparent substrate having a diffraction grating formed on a surface thereof;

a separation coating formed on the diffraction grating of the transparent substrate so as to reflect or transmit incident light according to how the incident light is polarized; and

a plate-shaped transparent member kept in intimate contact with the diffraction grating of the transparent substrate with the separation coating sandwiched in between.

42. A diffraction grating device as claimed in claim 41,

wherein light reflected from the separation coating is totally reflected inside the transparent substrate and is thereby directed to an end surface of the transparent substrate.

43. An illumination optical system comprising:

a diffraction grating device comprising:

a plate-shaped transparent substrate having a diffraction grating formed on a surface thereof; and

a separation coating formed on the diffraction grating of the transparent substrate so as to reflect or transmit incident light according to properties of the incident light,

wherein the illumination optical system uses the diffraction grating device both to direct light to an object to be illuminated so as to illuminate the object and to direct light reflected from the object out of the illumination optical system by letting this light pass

through the diffraction grating.

44. An illumination optical system as claimed in claim 43,

wherein the diffraction grating device further comprises:

a plate-shaped transparent member kept in intimate contact with the diffraction grating of the transparent substrate with the separation coating sandwiched in between.

45. An illumination optical system as claimed in claim 43,

wherein the separation coating reflects or transmits the incident light according to an angle of incidence of the incident light.

46. An illumination optical system as claimed in claim 43,

wherein the separation coating is a chiral nematic liquid crystal layer that reflects one and transmits another of two circularly polarized light components having different rotation directions.